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ABSTRACT

The laboratory phase of a materials course at the General Motors Institute is described. In the first six weeks of the laboratory, each student works individually to learn laboratory techniques; in the last six weeks the students work in teams of two on a project. The students are responsible for writing a project proposal and a project evaluation. (MLH)

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AMERICAN SOCIETY FOR ENGINEERING EDUCATION

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"PROJECT ORIENTED MATERIALS LAB"

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PROJECT ORIENTED MATERIALS LABORATORY

INTRODUCTION

General Motors Institute (G.M.I.) will be a cooperative education school of about 2000 students, as of February 1976. The students are non-materials students; that is they are Mechanical Engineers, Electrical Engineers and Industrial Engineers. Students alternate between six-week periods of academic study and six weeks of related work experience in their sponsoring plants. Plant sponsorship is required for attendance at G.M.I.

MATERIALS COURSES

During the first four semesters all engineering students take a common core of courses. Part of this common core is a three course materials sequence - starting with chemistry (Materials Science I) in the first semester and Materials Science II, Organic Chemistry, and Materials Science III "Metals" in the third and fourth semesters.

The Materials Science III course taught under the title C-27 is a service course. C-27 is a four credit, three class hour, two lab hour per week course. Class sizes are about 24 people with lab sizes about 12. (Two lab sections for each class section.) Originally, class and lab populations were equal, but when the project lab system was adopted about three years ago, it was felt that a smaller student-teacher ratio would provide a more effective laboratory experience for

the student. In retrospect this was a wise decision because of the time commitment required by the faculty and the amount of available equipment in the second six weeks.

Because of the operation of the cooperative program, courses are essentially divided into two six-week parts. This division lends itself nicely to a project-oriented laboratory.

First Six Weeks (Students Work Individually)

In the first six weeks the objectives are:

a. To become familiar with basic physical testing equipment.
b. To know the theoretical basis for hardness testing.
c. Be able to operate and take data from a tensile machine, hardness testers (Rockwell, Brinell, Wolpert) and impact tester.
d. Be able to cut, mount, polish, etch and photograph a micro sample.
e. Be able to operate furnaces and rolling mill
f. Know proper quenching technique

These objectives are accomplished through lectures, demonstrations, and practical experience by the student. In the first section, the students are exposed to various experiences:

First Six Weeks - Outline

Hardness and heat treatment;
Tensile test and mounting of specimens (from first lab);
Hand polishing of micro specimens;
Micro examination and micro photography;
5. Cold work and recrystallization; and
6. Discussion of work, review and test.

In the classroom segment of the section, the student is exposed to material which is supported by his lab experiences. For example,

mechanical properties, crystal structure, diffusion, and phase diagrams are discussed. These subjects, plus his practical laboratory experience, prepare him for the project phase of the lab. Prior to the last lab class of the first six weeks, each student receives a handout explaining in detail what is expected of him in the following section. (Handout is appended.) This handout is subsequently discussed in the last laboratory of the section and any questions regarding the project portion of the lab are answered. This allows the student the option of picking a project related to his work experience or his plant environment if he so desires.

Second Six Weeks (Students Work In 2-Man Teams)

A project is chosen at the first lab period of the second six week session. The students must present a proposal of their project before they begin. Each proposal contains (a) a problem statement, (b) a plan of attack, (c) a time table, and (d) an evaluation scheme. It is the intention of this proposal to make each student team determine a plan with an evaluation criteria before beginning and thereby avoid any difficulties later. Along with this proposal, they are asked to find current references to procedures and evaluations techniques as used in current engineering practice.

Before a team can begin work, the proposal must be approved by the instructor. A meeting is set up between both team members and the instructor for this purpose. It is hoped that during this meeting any

pitfalls in the plan can be eliminated and after this meeting the investigation can be run smoothly and completed in the time allotted. After approval is obtained, the students are free to work at their own pace and an open lab concept is maintained. By the open lab, it is meant that during the course of a week, the students are allowed to come into either of the two labs that are associated with the class they are taking, plus there are periods when a student lab assistant is in the laboratory so they can work on their own. This facilitates long term heat treatments and more complicated arrangements that can not be done in a normal two hour lab. During execution of the project, the class instructor is available to consult on problems and to discuss the information gathered by the students.

The last phase of the process is the reporting of their findings. This is done in both oral and written form. The oral report is a defense of the method and the data collected and is conducted in the classroom in conjunction with the other students. This allows each student to become aware of the work being done and information gathered by the other students.

THE EVALUATION

Evaluation of a project is done by both the professor and the students. The students are given a handout sheet and asked to grade each oral report for technical content and presentation (Handout appended). The professor evaluates this performance based on:

a. How well the student followed the proposed plan.

b. If bad data are obtained, how well do they account for the deviation.

c. Work method.

d. Are the conclusions and recommendations consistent with the data.

Generally allowances are made for equipment malfunction or other unforeseen delays. In addition, during the project students are allowed to re-evaluate a method and change their original plan upon presenting proper justification. These types of deviations are allowed without penalty. Grading is done as much as possible without regard to class grades and unfortunately is subjective in nature. If the students follow their plan, use reasonable data collection methods, and don't make any major mistakes in their discussion or conclusions they can expect a grade of "B" for their written report and the technical portion of the oral report. Presentation grades are given based on format and delivery and are about 20% of the total lab grade.

PROJECTS

The basic philosophy of the project-oriented lab is to involve the students in a challenging investigation in which he can relate to a problem, become familiar with testing techniques, be free to apply his ingenuity and experience to extract information, and to relate the lecture material to the laboratory experience.

Some typical projects: The evaluation of screw drivers. The students purchased a number of commercially available screw drivers and

compared their relative characteristics and evaluated these characteristics on a quality scale. The final recommendation ranked the tools from those suitable for opening paint cans to those a mechanic would purchase for a long term use.

Another student team attempted to show the properties of a lower strength alloy steel fastener to that of a higher strength fastener by heat treatment.

There have been numerous projects on sheet metal testing, impacting of sheet metal specimens, Olson cup drawing experiments using various heat treated sheets and non-ferrous materials. Projects can and do take many forms. The ideas are limited only by the imagination of the student. (Additional project titles are listed in the Appendix.)

The freedom of this form of laboratory experience is considerably more rewarding for both student and professor than a conventional "canned" laboratory. In general, the project lab is well accepted by the students, even though the length and difficulties of the problem are greater than in conventional labs.

Some question has been raised as to the lack of a "well rounded" lab program. This would be one in which the student sees a number of planned experiments to illustrate certain phenomenon that correlate with the class lecture. The project lab in some ways limits the exposure of the student but in turn it creates a "need to know" atmosphere. At the same time, the involvement of the students among themselves and with the professor, fosters questions and greater

interaction. Because of this interplay I believe a much greater understanding is actually achieved.

SUMMARY

In summary the key ingredients for a successful project-oriented lab are small classes, time commitment on the part of the instructor and an imaginative student body.

It is hoped that this brief presentation has given you an insight to the method by which we conduct a laboratory in the materials area and hopefully will stimulate you to try new methods by which students may more profitably study materials.

APPENDIX A

C-27 LAB PROJECT

During the second six weeks session you will be asked to do a project on the evaluation of some material or process dealing with materials. This project is of your choice. You may investigate any materials problem provided (1) it can be done with the equipment available at G.M.I. and (2) the scope of the project permits its completion in the allotted six weeks.

The purpose of this project is to allow you to investigate an area of materials that you consider interesting.

The following is a list of the requirements for this project:

1. During the first lab period of the seventh week you will be asked to submit a proposal for your project. This proposal will consist of the following items:
   (a) The subject of your investigation. This should be the title of your final report.
   (b) An explanation of the problem area you intend to investigate.
   (c) The names of the team members. Each team will consist of two persons.
   (d) A list of materials needed in your project.
   (e) The type of equipment that you will be using such as furnaces, hardness testing machines, tensile testing machines, etc.
   (f) How you propose to evaluate the information that you have gathered. By this I mean what graphs you intend to draw; what specific properties are you intending to characterize; how you will characterize them.
   (g) A time table for your proposed project.

This proposal will be typed and submitted before your begin working. In order to gain approval for working, each student team will be questioned on the project in order to determine how well they have conceived the project. At this time, if approval is granted, the students can begin the project portion of the laboratory.

2. After the project is completed, the following information and reports will be submitted. Each team will be asked to prepare a written and an oral report of their project. The oral report will be presented

to the entire class. This oral report will be graded based on the presentation and your ability to answer questions from the group. Your grade for this presentation will be determined by my evaluation and by a classroom evaluation of your peers. Secondly, the written report will consist of the raw data that you have taken and presented in a neat tabular format. This need not be type. You will present your evaluation of the data in some form. Most convenient for engineering purposes is a graphical format. You will present conclusions and recommendations if they suit your project. And finally you will be asked to discuss your data in not more than five typed pages.

If during your work experience, you encounter something that you feel would be a reasonable project please feel free to call me at 8+446+9882 to discuss this idea. If by the end of the first week of class in the new section, you have not determined a project, I will assign a project of my choice at that time.

C V White

C. V. White

CVW/ms

APPENDIX B

STUDENT EVALUATION OF ORAL PRESENTATIONS

Please judge each presentation on technical content and presentation.

Assign a grade of 1 (failing) to 5 (excellent).

As a guide line --

Technical Content

A) Does the information sound reasonable?

B) Are the data saying the same thing as the speaker?

C) Did they make any errors in their method?

D) Can they answer reasonable questions on the subject?

Presentation

A) Can you hear the speakers?

B) Do the visual aids make sense - can you read them?

C) Did they read the report?

Talk	Speakers	Technical	Presentation	Comments
1				
2				
3				
4				
5				

APPENDIX C

TOPICS

--- Mechanical Properties of Tin-Lead Solder Joints

--- Hardenability of 1038 Steel

--- A Comparison of Different Lubricants Use on Sheet Metal in the Olson Cup Drawing Machine

--- A Study of Ring Gear Cooling Rates

--- Effect of Tempering on the Properties of 3620 Steel

--- Determination of Correct Heat Treatment of SAE Grade 2 Bolt for Replacement of SAE Grade 5 Bolt

--- Creep Characteristics of Z Die Castings vs. Al Die Castings

--- A Study of HSLA Steel Impact Properties at Low Temperature

--- Effects of Part Size on Hardening of Grey Cast Iron

--- Steel vs. Al Beer Cans

--- Metallurgical Analysis of Guitar Strings